LC2: Representing the Study Site in a Diagram

Purpose

For students to learn the skills and value of translating complex interactions among Earth system components into a simplified diagram

Overview

Students develop their ability to understand and draw a diagram of their study site as a system of interconnected components. Beginning with photographs of their study site, students label Earth system components and interconnections, and then produce a simplified diagram of the site. After sharing and discussing the labels and relationships on their diagrams, students further revise their drawings.

Student Outcomes

Students will be able to:

- Analyze a photograph of their study site with respect to Earth systems;
- Annotate interconnections among Earth system components on a photograph;
- Translate their analysis of the study site into a diagram of the site;
- Produce a simplified diagram of the site;
- Interpret, evaluate, and constructively criticize the diagrams of other students.

Science Concepts

Physical Sciences

Heat is transferred by conduction, convection and radiation.

Heat moves from warmer to colder objects.

Sun is a major source of energy for changes on the Earth's surface.

Energy is conserved.

Chemical reactions take place in every part of the environment.

Earth and Space Sciences

Weather changes from day to day and over the seasons.

The sun is the major source of energy at Earth's surface.

Solar insolation drives atmospheric and ocean circulation

Each element moves among different reservoirs (biosphere, lithosphere, atmosphere, hydrosphere).

Life Sciences

Organisms can only survive in environments where their needs are met.

Earth has many different environments that support different combinations of organisms.

Organisms' functions relate to their environment.

Organisms change the environment in which they live.

Humans can change natural environments.

Plants and animals have life cycles.

Ecosystems demonstrate the complementary nature of structure and function.

All organisms must be able to obtain and use resources while living in a constantly changing environment.

All populations living together and the physical factors with which they interact constitute an ecosystem.

Populations of organisms can be categorized by the function they serve in the ecosystem.

Sunlight is the major source of energy for ecosystems.

The number of animals, plants and microorganisms an ecosystem can support depends on the available resources.

Atoms and molecules cycle among the living and non-living components of the ecosystem.

Scientific Inquiry Abilities

Communicating science concepts through diagramming

Evaluating diagrams of other students

Presenting evidence to support ideas and justify decisions

Develop explanations and predictions using evidence.

Recognize and analyze alternative explanations.

Communicate results and explanations.

Time

90 minutes (Two class periods)

Level

Middle, Secondary

Materials and Tools

One copy of your study site photograph for each student, *(or* copy Figure EA-LC2-1)

List of interconnections from *Activity LC1*, either your students' own or the sample list

Preparation

Select a study site (if you didn't do *LC1*).

Create or obtain one or more photographs of the study site.

Read *Diagramming Earth as a System.*

Make student copies.

Prerequisites

None

Special Notes

About Diagramming

As explained in *Diagramming Earth as a System*, students progress from literal diagrams to more symbolic and abstract representations. This progression can be described as a set of four phases (only the first three phases are required in this activity. The fourth phase is optional, for advanced students):

Phase 1. Photograph with annotations (sentences or phrases with verbs)

Phase 2. Literal diagram of the site based on the photograph; phrases used in Phase 1 retained (and perhaps embellished)

Phase 3. Simplified diagram; verbs replaced with arrows

Phase 4. Abstract representation where symbols and color and size keys are used for all representations

A separate student product culminates from the first three phases in this activity. The Phase 3 diagram will be used in *Activity LC4*.

Advanced students are capable of greater degrees of abstraction, and should be able to develop a completely abstract diagram with arrows. The teacher can gauge the degree of abstraction that each class (or individual student) is capable of, and shape this activity accordingly.

The completely abstract diagram is suggested as an optional student product.

About Posting a List of Interconnections on the Board (See Step 4.)

If you leave the list of interconnections on the board for an extended time during and after this activity, students will have more opportunities to absorb the information and to reflect on how it applies to their diagrams of the study site.

It will be important for students to have time to revise and refine their diagrams. It may be appropriate for some students to do revisions as a homework assignment.

What To Do and How To Do It

Step 1. Preparation

Select a Study Site

If you did not conduct Activity LC1, you will need to select a study site. It can be the same as the study site for the GLOBE *Hydrology Investigation*. It should be one that is familiar to students. The most appropriate site will have representations of water, soil, air, and living things. A site adjacent to a canal, pond, or stream would be a good one. If such a body of water is not available, you can use any site where plants and animals (of any type) are living under natural conditions.

Obtain a Photograph of the Study Site

If you did not conduct *Activity LC1*, take photographs of the study site now. Select one photo that shows all the major features of the study site, and copy it for students. Copies of black-and-white prints will work. You may choose to make overhead transparencies of some photographs, to support classroom discussions.

Read

Diagramming Earth as a System in the Introductory section of *Exploring the Connections* in the *Earth as a System* chapter of the *GLOBE Teachers Guide*, if you have not done so already. It will provide guidance as you help your students with their diagramming. You may choose to make copies of this for your students also.

Make Student Copies

Guidance for Students
- *Annotating a Study Site Photograph*
- *Diagramming Your Study Site*

Work Sheets:
- *Student Self-reflection Log: The Study Site as a System*
- *Student Self-reflection Log: What Have You Learned from Diagramming Your Study Site?*

Assessment rubrics for this activity (You may want to share with students.)

In addition, if you have not conducted *Activity LC1*, make student copies from that activity of:

Sample Student List of Interconnections;
Figure EA-LC2-1, Photographs of Reynolds Jr. Sr. High School study site.

Step 2. *(If you did not conduct the Activity LC1)* **Introduce the activity with a discussion of dramatic events or changes that have occurred in your local area.**

Ask students to suggest events or changes, such as drought, flood, hurricane, fire, or loss of a particular habitat such as a wetland. Have students describe these events. What changed? What do people understand about it? What don't people understand? What do we still need to find out?

Explain that a new discipline of science – Earth System Science has emerged, one in which people attempt to understand changes like these by learning more about ways that parts of the Earth interact to shape the environment. Earth system science integrates all sciences that are concerned with the Earth: geology, hydrology, chemistry, botany and zoology, and meteorology.

People who study the Earth as a system are pioneers in this new discipline, and, as experts on their own local areas, GLOBE students can participate. Every area, every site is unique in certain ways. Ask students: How would you apply Earth system science to one of your study sites? How would you communicate the *system* aspect of your study site – its parts and how they interact – to students at another GLOBE school?

Explain that each one of the activities in the *Local Connections (LC)* series addresses aspects of this question.

Step 3: Help students identify four major components of the study site as an Earth system (or, if you conducted *Activity LC1*, remind them):

Air
Water
Soil
Living things

(If you did not conduct *Activity LC1*, during which students visit their own study site, distribute copies of the Figure EA-LC2-1.)

Explain that scientists use the terms atmosphere, hydrosphere, pedosphere, and biosphere when referring to these components. The terms correlate with the titles of GLOBE investigations: *Atmosphere, Hydrology, Soil,* and *Land Cover/ Biology.*

Write these terms across the top of the board, making column headings under which specific interconnections will be listed.

Step 4. Using your students' lists of interconnections from *Activity LC1* (if you conducted it), or the Sample Student List of Interconnections from *Activity LC1,* have the class determine which of the four major Earth system components are involved in each interconnection.

Distribute the list of interconnections, or have students retrieve their own lists (which should include their homework from *Activity LC1*). Ask volunteers to describe some of the interconnections, and have the class determine which of the 4 major study site components are involved with each. The teacher or a selected student can list the interconnection on the board under the appropriate component headings. There should be two components involved in each interconnection.

If you conducted Activity LC1, continue with Step 5. If you did not conduct Activity LC1, go directly to Step 6.

Step 5. Once at least two or three interconnections for each component have been listed, discuss students' designations of each interconnection as being based on data (D), background information (B), or scientifically informed speculation (S), as described in *Activity LC1*.

Students should have written these designations next to each of the interconnections on their own lists, as homework. Go through this designation exercise as a class, with those interconnections already written on the board. Ask students to share their designations, and make sure that students can justify the designations they have used.

Some designations may be controversial, which can stimulate a lively discussion about the validity of different information sources.

Step 6. Have students share and discuss these and any other interconnections that occur to them.

Allow students to modify their own lists if they made them in *Activity LC1*.

Require students to justify their ideas on the basis of data or authoritative background information that they would be able to produce, given enough time. Creative speculation should be encouraged, as long as it is based on sound scientific information. Encourage discussion of controversial ideas.

Step 7. Remind students that they are dealing with the study site as a system.

Explain to students that they will be using what they have learned about the parts and interconnections of their study site to make a diagram of the site. This will result in a product that represents their site which they may share with students at other schools. A helpful first step toward this diagramming is to make notes on, or *annotate*, a photograph of the study site.

Step 8. Have students annotate their copies of the study site photograph.

Distribute copies of the photograph you have selected to show the study site, and copies of the Student Work Sheet, *Annotating a Study Site Photograph.* Ask students to annotate their copies in the following way:

1. Label the four major components.

2. Add short descriptions of the interconnections among them, using verbs in phrases or short sentences.

These will be "Phase One" annotated photographs, as described in *About Diagramming* in Special Notes, above.

If you need to use more than one photograph of the study site to capture all of the important features of the system, you can show it to students, but they should use only one image of the site for their annotations.

If there is not enough space for annotations on the photograph, students can attach it to a piece of paper.

Although instructions for students appear on their work sheets, you may wish to write instructions on an overhead transparency or on the board as well. Make sure students understand that their annotations are to show *connections* or *relationships* between components of the system, just as their lists of interconnections have done.

If a student represents an interconnection as going only one way, can she or he think of how it might also go the other way?

See Figure EA-LC2-2 for an example of an annotated photograph.

Advanced students may be capable of skipping Step 10, going directly from Step 9 to Step 11.

Step 9. (Optional) **Have students write a short reflection on their own learning.**

If this kind of work is new to some of your students, you may want to take five or ten minutes to make sure they have understood everything so far. Distribute the *Work Sheet, The Study Site as a System: Student Self-reflection Log.* Collect what they write, and review it while students are engaged in the next step of the activity.

Step 10. Now have students make a diagram of the study site, using their annotated photographs as guides.

These will be "Phase Two" diagrams, as described in *About Diagramming* in Special Notes above. Distribute copies of the *Diagramming Your Study Site (Literal Diagram): Work Sheet–3* for students to read as guidance in creating a simplified diagram.

Explain to students that they should simplify what appears in the photograph, but their diagrams should represent everything in the photograph. Let students know that a little later in the activity they will have opportunities to simplify their diagrams.

Students who are uncomfortable with drawing can use simple shapes to represent elements of the study site. Make it clear that this is not a drawing competition!

Students should annotate their diagrams with the same phrases or sentences they used on their annotated copies of the photograph, and they should retain the designations of the sources of their information (D, B, or S, for data, background information, or scientifically informed speculation). Encourage them to add new interconnections if more have occurred to them. They should make all annotations simple and clear.

Let students know that they can include people in their diagrams!

See Figure EA-LC2-3 for an example of an annotated literal diagram.

Step 11. Have students make simplified diagrams.

These will be "Phase Three" diagrams, as described in *About Diagramming* in Special Notes above. Distribute copies of the *Diagramming Your Study Site-Simplified Diagram Work Sheet-4* for students to read as guidance in creating a simplified diagram.

Instruct students to use arrows to represent the verbs they used in their annotated photographs and literal diagrams. They should draw one-headed arrows to indicate the directions in which the interactions are occurring, showing only one direction on each arrow.

Instead of drawing lots of trees, students can draw two or three. Instead of drawing a multitude of raindrops, they can draw one raindrop, or a small cluster. Instead of a sky full of clouds, they can draw one cloud.

As students simplify their diagrams, they will make decisions about what is most important to keep. This means they will make decisions about the essential elements of an Earth system.

Be sure to check students' work partway through this step. Particularly if diagramming is a new process for them, they may need guidance and feedback.

See Figure EA-LC2-4 for an example of an annotated simplified diagram.

Step 12. Have students share their diagrams in pairs.

Students in pairs should interpret and describe each other's diagrams. The student who made the diagram can listen and discover what s/he

has communicated clearly and what s/he needs to improve on.

Encourage students to evaluate their partners' diagrams carefully, to ask questions about aspects that are unclear, and to offer only criticism that is constructive. Tell the class that they will be evaluated on the degree to which their comments on each other's work are positive and contribute to learning.

Suggest that students make notes on the characteristics of effective diagrams.

Step 13. (Optional, use for Advanced Level Students) **Have students develop abstract versions of their diagrams.**

These will be "Phase 4" diagrams, as described in *About Diagramming* in Special Notes above.

Instruct students to:

1. Use symbols for the interconnections in their simplified diagrams (made in Step 11); and
2. Retain their arrows to show interconnections.

Step 14. (Optional) **Ask students to complete another self-reflection log.**

Distribute *Student Self-reflection Log: What Have You Learned from Diagramming Your Study Site?: Work Sheet-5,* and ask students to complete it.

Step 15. If you plan to conduct *Activity LC3,* **prepare students for it.**

Tell students that interconnections among Earth system components can be explored mathematically, in graphs, as well as visually, in diagrams. Let them know that in the next activity, they will make graphs of GLOBE data, and will find out what can be learned through that medium about interconnections.

Step 16. Collect annotated photographs, student lists of interconnections, and diagrams for assessment.

If you plan to conduct *Activity LC4, Diagramming the Study Site for Others,* note that students' diagrams will be needed for that activity.

Student Assessment

These student products can be used for assessment:

- Annotated photographs ("Phase 1" of diagramming)
- Literal diagram ("Phase 2" of diagramming)
- Simplified diagram ("Phase 3" of diagramming)
- Students' interpersonal and communication skills when they receive and give feedback on the diagrams of others
- *Student Self-reflection Log: The Study Site as a System*
- *Student Self-reflection Log: What Have You Learned from Diagramming Your Study Site?*

Rubrics are provided for assessment of the annotated photographs, diagrams, and student interpersonal and communication skills when receiving and giving feedback are provided.

Though what students write on self-reflection is not assessed in quantifiable terms, the logs play an important role, and can be used to help shape the next stage of teaching.

Further Investigations

Familiar Systems

Ask students to name some systems. If they need prompting, suggest sports teams, groups of friends, car engines, etc. Ask students to identify the parts, or components, of each system, and ways those components interconnect. Ask students to sketch a diagram of any system they choose.

Figure EA-LC2-1: Photograph of Reynolds Jr. High School Study Site in Greenville, Pennsylvania USA

Figure EA-LC2-2: Annotated Photograph of Study Site at Reynolds Jr. Sr. High School

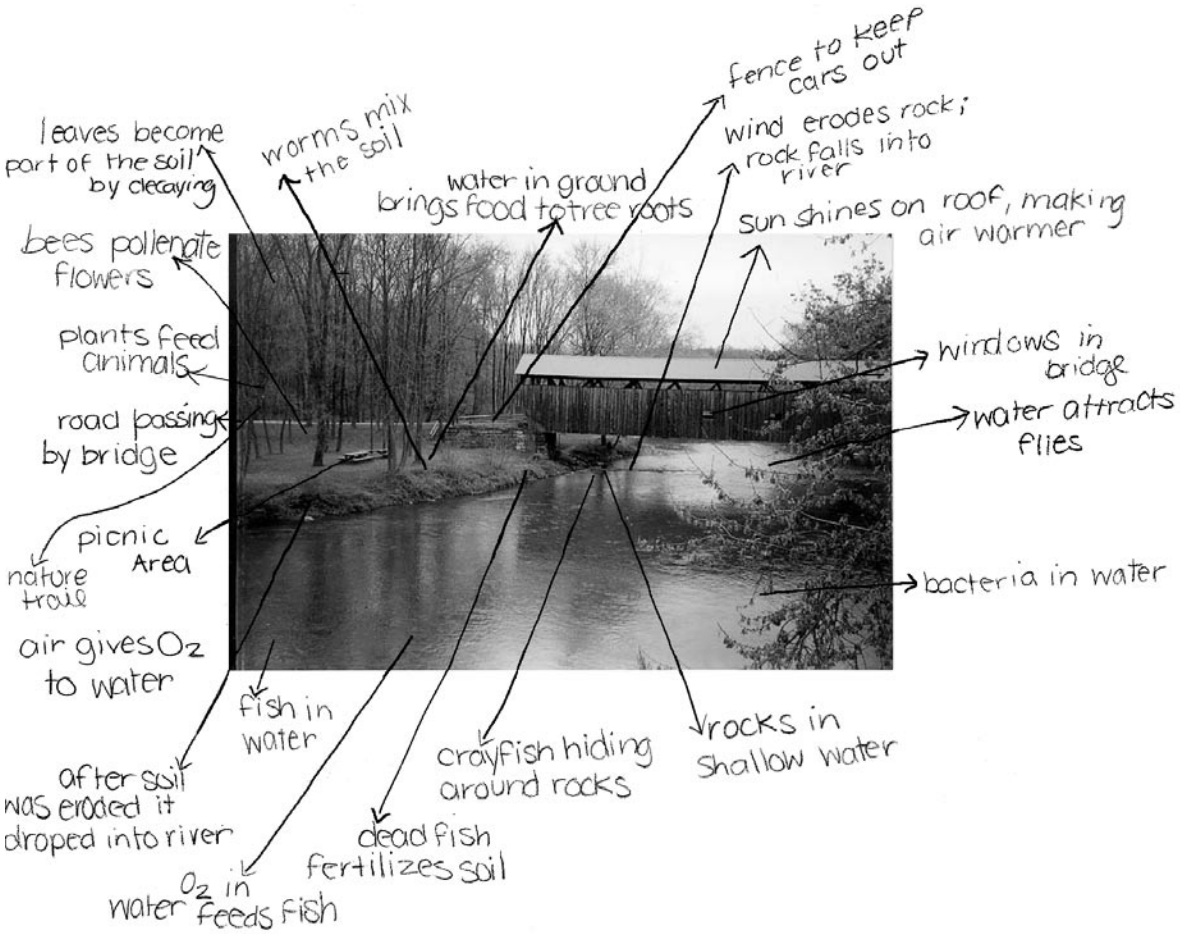


Figure EA-LC2-3: Annotated Literal Diagram of Hydrology Study Site at Reynolds Jr. Sr. High School

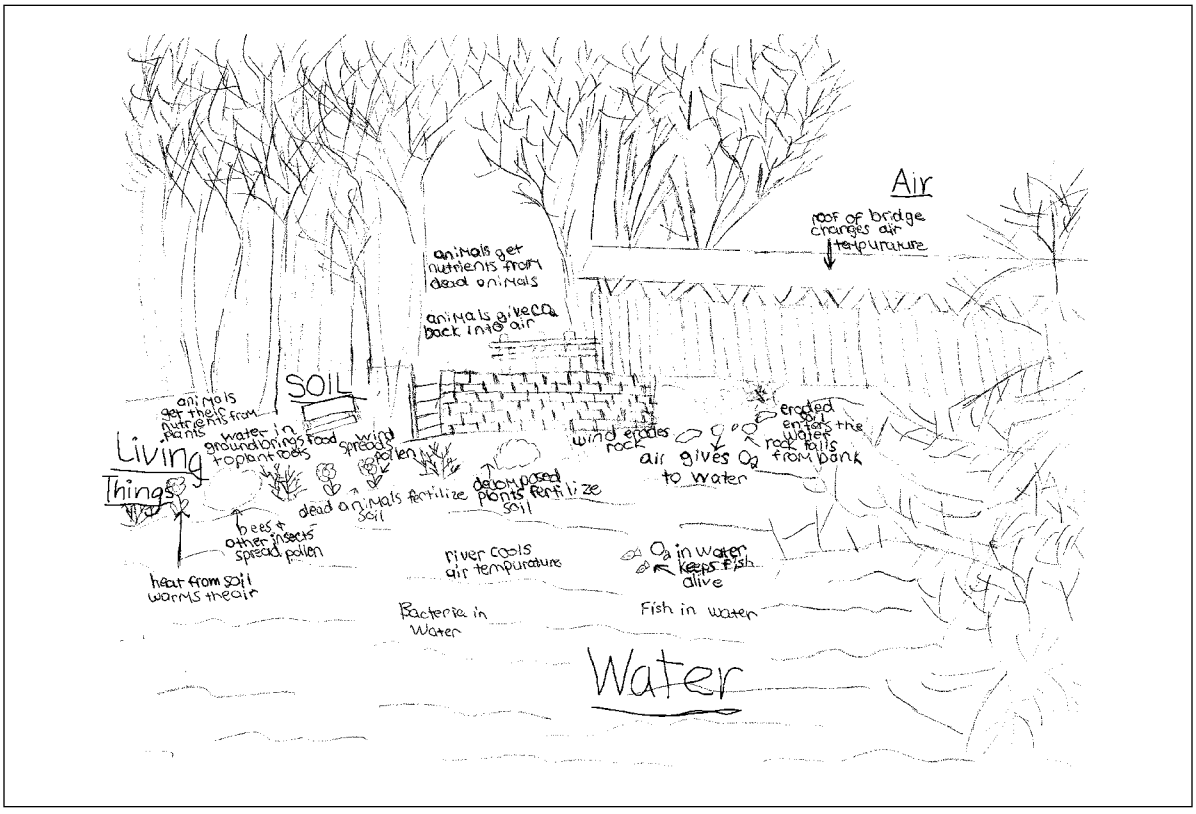
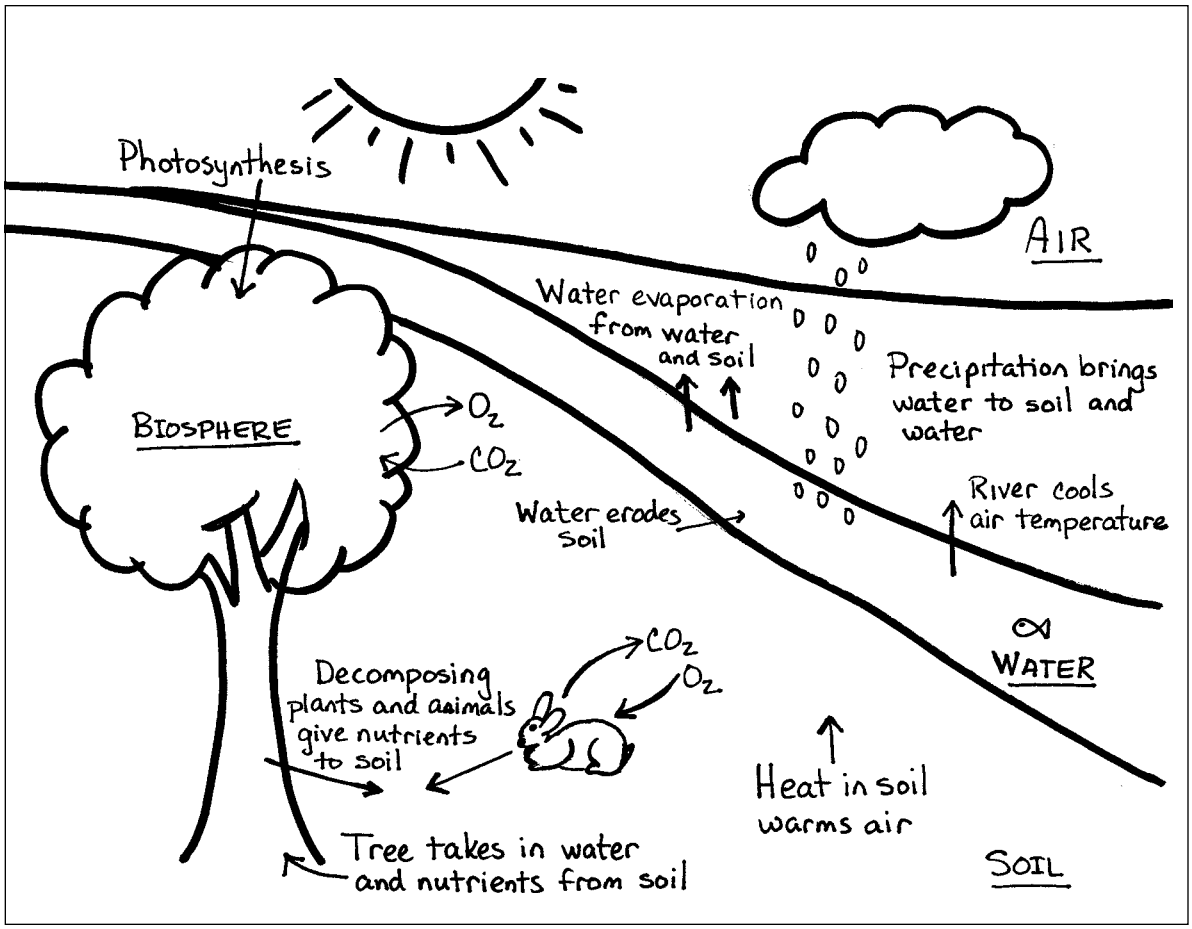


Figure EA-LC2-4: Annotated Simplified Diagram of Hydrology Study Site at Reynolds Jr. Sr. High School



Annotating a Study Site Photograph

Work Sheet-1

Name:_____ Class: _____Date:_____

To annotate means to describe with short notes. Annotate your study site photograph (on the sheet to which your photograph is attached) in the following way:

1. Label the four major components of the study site system: atmosphere, hydrosphere, pedosphere (soil), and biosphere.

2. Using the list of interconnections you developed in the previous activity, or the list that GLOBE has provided, write short descriptions of the interconnections among the components of the system, as shown in the photograph.

Follow these guidelines:

1. Use phrases or short sentences with verbs.

2. Make sure you are describing *connections* or *relationships* between components of the system, just as in the list of interconnections.

3. *Write as clearly as possible.* Remember that other students must be able to understand your work.

4. If you run out of space for your annotations, put a number next to the feature in the photograph that you're writing about, draw a small circle around the number so that it will be easy to see, and write the annotation on a separate piece of paper. Attach the piece of paper to your photograph.

5. If your photograph does not show important features that you know about at the study site, you can include them in your annotations in the same way as suggested above.

6. Attach your photograph with annotations to this sheet.

The Study Site as a System

Work Sheet-2: Student Self-reflection Log

Name:_____ Class: _____Date:_____

Your responses to the questions below are intended to help your teacher become aware of what you're thinking and what you may need help understanding. *You will not be graded on these responses.*

1. What have you learned about ways that the components of a study site interact as a system, that you feel confident about?

   _____

   _____

   _____

   _____

   _____

2. What are you having trouble understanding about the interactions among components of a study site?

   _____

   _____

   _____

   _____

   _____

3. What would you like to know more about?

   _____

   _____

   _____

   _____

   _____

Diagramming Your Study Site (Literal Diagram)

Work Sheet-3

Name:_____ Class: _____Date:_____

Use your annotated photograph to make a literal diagram of your study site. The purpose of this diagram is for you to communicate what you see as the components of the Earth system in your study site and how they interact with each other. If you have trouble drawing, use simple shapes to indicate different things and label them.

Follow these guidelines in creating your literal diagram.

1. In your literal diagram include and label every component of the Earth system that appears in your annotated photograph.

2. Indicate all of the interconnections you identified in your annotated photograph using the phrases or short sentences with verbs to describe them. Be sure to indicate where the interconnection is and between what components it is occurring.

3. In creating your literal diagram are there any other components that you did not notice or label before? If so, add those components to your literal diagram and label them.

4. In creating your literal diagram are there any other interconnections between components that you did not label on your annotated photograph? If so, add those to your literal diagram now. Be sure to indicate where the interconnection is and between what components it is occurring.

Diagramming Your Study Site (Simplified Diagram)

Work Sheet-4

Name:_____ Class: _____Date:_____

First of all, there is *no one right way* to make a diagram. Your style of diagramming may be very different from someone else's. What matters is that it is *accurate* and *complete,* and that it *clearly communicates your ideas.* Other students must be able to understand your idea just by looking at the diagram.

Second, you may want to revise this diagram more than once. Make it as good as you can, but be aware that you will have opportunities to revise it.

Use your annotated photograph and your literal diagram as the basis for this diagram. Follow these guidelines:

1. Draw and label the four major components of the study site system. (By now you should know what they are!)
2. Use arrows to represent the verbs you used in your annotated photograph and your literal diagram. Draw one-headed arrows to indicate in which direction each interaction is occurring. Show only one direction on each arrow.
3. On the shaft of the arrow, indicate what is moving from one component to the other (such as rain moving from atmosphere to pedosphere).

Be aware that as you simplify your literal diagram into a simplified diagram, you will make decisions about what is most important to keep. This means that you are making decisions about what the essential elements of the Earth system at your study site are.

4. Attach your work to this sheet.

What Have You Learned from Diagramming Your Study Site?

Work Sheet-5: Student Self-reflection Log

Name:_____ Class: _____Date:_____

1. What have you learned about the study site itself?

_____

_____

_____

_____

_____

_____

_____

2. What have you learned about diagramming?

_____

_____

_____

_____

_____

_____

_____

3. What qualities or diagramming techniques did you find valuable in your partner's diagram?,

_____

_____

_____

_____

_____

_____

_____

Assessment Rubric: *LC2: Representing the Study Site in a Diagram*

Annotated Photographs of the Study Site

	4	3	2	1
Study Site Components Included	Includes and correctly identifies all 4 major components	Includes and correctly identifies 3 major components	Includes and correctly identifies 2 major components	Incompletely and/or incorrectly includes and identifies major components
Scientifically Accurate Interconnections	Lists several scientifically accurate interconnections for each component of study site; reflects all of expected science knowledge	Lists 2-3 scientifically accurate interconnections for each component of study site; reflects most of expected science knowledge	Lists 1 or 2 scientifically accurate interconnections for 2 or 3 components of study site; reflects some of expected science knowledge	Lists no scientifically accurate interconnections; reflects little expected science knowledge
Clarity of Descriptions	Writes clearly and succinctly; uses verbs and specific references to indicate all interconnections	Writes clearly; uses verbs and specific references to indicate most interconnections	Needs to improve clarity of writing; uses vague references to indicate most interconnections	Needs to improve clarity of writing significantly

Assessment Rubric: *LC2: Representing the Study Site in a Diagram*

Diagrams of the Study Site

	4	3	2	1
Study Site Components Included	Includes and correctly identifies all 4 major components	Includes and correctly identifies 3 major components	Includes and correctly identifies 2 major components	Incompletely and/or incorrectly includes and identifies major components
Interconnections Represented knowledge	Fully develops interconnections among all components of site, and demonstrates all expected science knowledge	Adequately develops interconnections among all components of site, and demonstrates most expected science knowledge	Partially develops interconnections among components of site, and demonstrates some expected science knowledge	Inadequately develops interconnections among components of site, and demonstrates little expected science
Choices for Simplification in Diagram	Chooses appropriate representations of components and interconnections to depict essence of study site as a system	Chooses mostly appropriate representations of components and interconnections to depict essence of study site as a system	Chooses some appropriate representations of components and interconnections to depict essence of study site as a system	Chooses inappropriate representations of components and interconnections to depict essence of study site as a system
Information Source Designations (D, B, S)	Identifies all information sources accurately and thoughtfully	Identifies most information sources accurately and thoughtfully	Identifies some information sources accurately and thoughtfully	Identifies few or no information sources accurately or thoughtfully
Clarity and Legibility	Writes and draws very legibly and clearly, with no errors	Writes and draws legibly and clearly, with few errors	Writes and draws unclearly, with some errors.	Writes and draws very unclearly, with many errors.

Assessment Rubric: *LC2: Representing the Study Site in a Diagram*

Interpersonal Skills: Receiving and Giving Feedback on Diagrams

	4	3	2	1
Listening Skills	Actively listens, and appears to highly value the constructive ideas of others	Listens, and appears to value the constructive ideas of others	Listens with less than complete attention; appears to somewhat value the constructive ideas of others	Appears to need significant improvement in listening skills, and in valuing the constructive ideas of others
Approach When Giving Feedback	Always uses constructive language; offers encouragement and specific suggestions	Usually uses constructive language; offers general suggestions	Sometimes uses constructive language	Rarely uses constructive language

Assessment Rubric: *LC2: Representing the Study Site in a Diagram*

Designating Information Sources for Interconnections

	4	3	2	1
Information Source Designations (D, B, S)	Identifies all information sources accurately and thoughtfully thoughtfully	Identifies most information sources accurately and thoughtfully	Identifies some information sources accurately and or thoughtfully	Identifies few or no information sources accurately